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BIO-AQUATIC NATURE OF INDIAN BOTANIC GARDEN LAKES

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ABSTRACT

Nine large lakes out of twenty five occurring in the Indian Botanic Garden, Howrah, have been studied for bio-aquatic nature. The characteristics of stational parameters are discussed. It is held that the dispositions of the lakes *vis-a-vis* temporal changes and the human interferences are responsible factors affecting proper conservation of these water bodies.

INTRODUCTION

The aquaphilous and terrestrial plan communities maintained at the Indian Botanic Garden (IBG) are found disposed against the extravagant progress of urbanisation and industrialisation on the one hand, and on the other, there is the action of dynamic forces of riverine onslaughts.

The Garden (net area 110 ha) is flanked on the north of the river Ganga (Hooghly) on the west bank at Sibpur within the district of Howrah in West Bengal (fig. 1). It stretches along 1.8 km facing the river on the south east. There is a dense human settlement at the remaining boundary of the Garden which is a source of concern for the conservation of its biota within. Occasional tidal bores during monsoon (July-Sept.) floods the area and inflicts damages to its flora and their habitat systems (Singh & Ghosh, 1985).

Except for the introduced and cultivated species, the distribution of general vegetation—both aquatic and terrestrial, appears to be strikingly heterogeneous. The present study is aimed at looking into the characteristics of the heterogeneity in the bio-aquatic environment of the garden lakes and their conservation whereas the bio-terrestrial nature is left out here for a separate treatment. (Singh & Ghosh, 1990).

The aquatic environment of the garden consists of a mosaic of interconnected lakes of varying dimensions. These are linked with the adjacent river-Ganga, with a free access to and fro of water, being controlled by a sluice mechanism on the South eastern side. The lakes number twenty five and together amount to one ninth of the total surface area of the garden.

For the purposes of the present study, the *Dhobi, Prain, King, Scortechin, Kunstler, Diwan, Janardan, Sadir* and *Leram* Lakes are selected for their representative dimensions and dispositions along the gradient of the garden.

METHODS

One composite water sample (from an average of 0.0-30.0 cm. depths) is collected from each lake under investigation for laboratory analyses at regular intervals of two months in a year. A total of fifty four water samples are analysed immediately after field collections for the Ca^{++}, Mg^{++} Na^{+} Co_3^{--} HCo_3^{-} and Cl^{-} as per procedures adopted in the Agriculture Hand Book (USDA) No. 60, 1954. The Sodium is analysed by using the Flame photometer,

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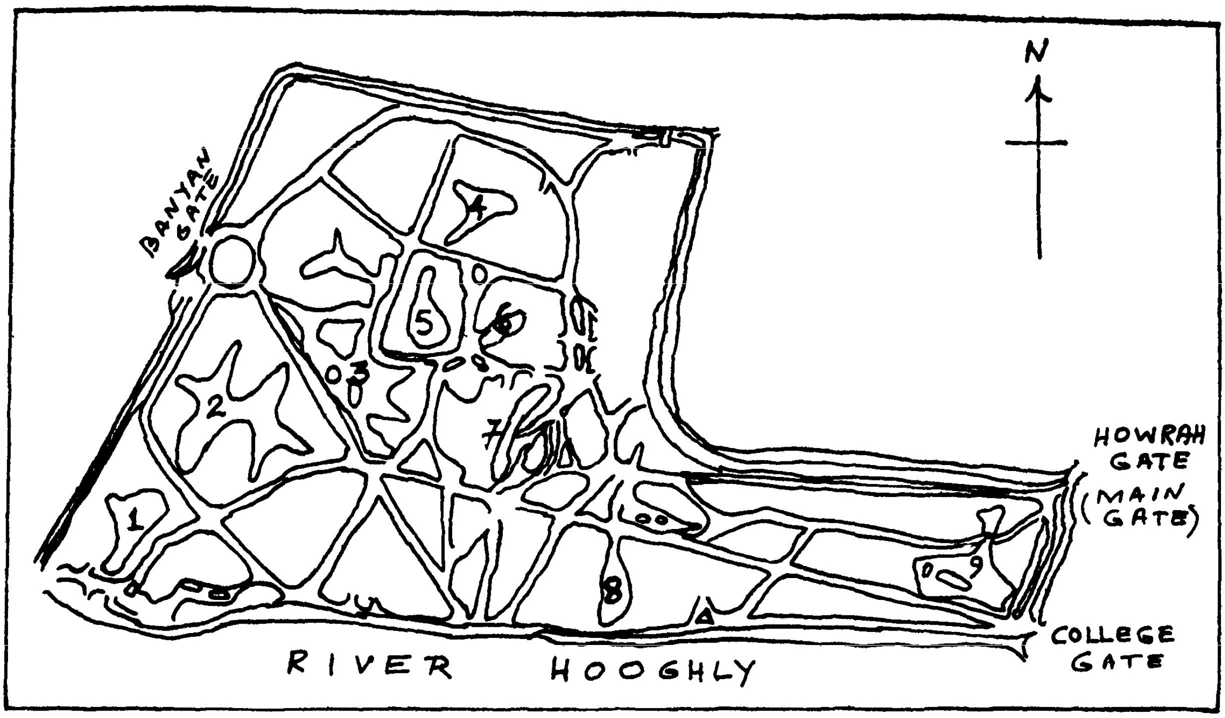

Fig. 1. Plan of Indian Botanic Garden and distribution of Lakes
1. Dhobi ; 2. Prain ; 3. King ; 4. Scortechin ; 5. Kunsteler ; 6. Diwan ; 7. Janardan ; 8. Shadir ; 9. Leram.

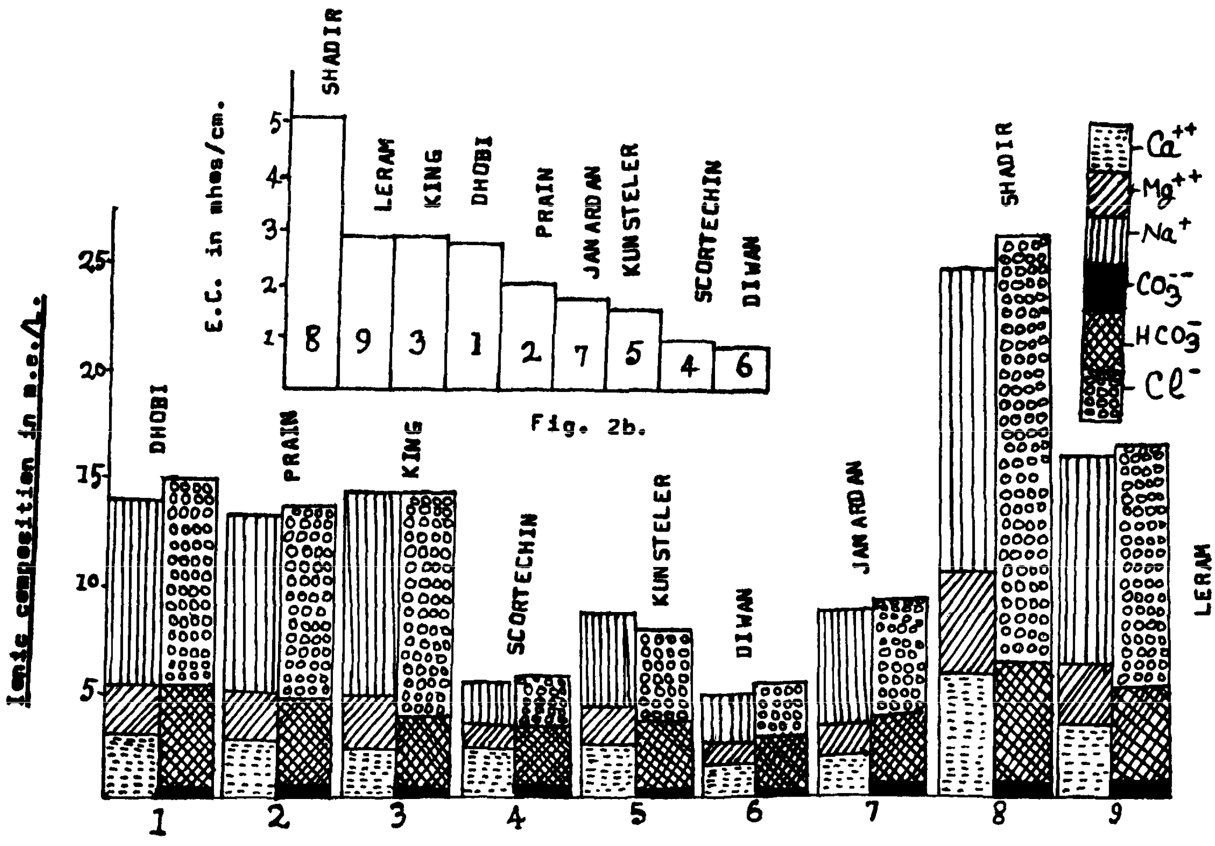

Fig. 2a. Showing the Ionic composition of Lake water. Fig. 2b. Showing the Salinity sequence of nine Lakes.

the pH by potentiometric method and Electrical conductivity (EC) by Conductivity bridge at 25°C. The other characteristics such as Soluble Sodium Percentage (SSP), Sodium Adsorption Ratio (SAR) and the residual Carbonate are determined by following the above reference.

For determining the phytosociological components of the aquatic habitats Braun-Blanquet method as adopted by Dominion (Kershaw, 1974) have been applied.

RESULTS AND DISCUSSIONS

The chemical constituents of bio-aquatic environment are discussed here. The periodic cationic and anionic variation of nine lakes and their related properties are presented in figures (2a, 2b) and (3) respectively.

It is clear from these observations that each lake is different from the other in their quantitative and qualitative chemical characteristics. A salinity sequence of these water bodies is proposed on the basis of mean annual electrical conductivity values (Table-1) in the order of Sadir>Leram>King>Dhobi >Prain>Janardan>Kunstler>Scortechin > Diwan Lakes. The origin of these diversities in the chemical nature of the given lake waters are due to the characteristics of the respective *in situ* soil compositions of the respective water bodies.

The chemical nature of water of the river Hooghly interferes certainly with the chemistry of the lake waters but it does not appeal to be a dominant factor though at times the water level of these lakes are maintained by allowing the inflow of the river water by mechanical devices. The Cl^- range of Sadir lake, for example, is 6.0 m.e./L to 25.5 m.e./L while the adjacent river water shows a maximum Cl^- concentration of 0.75 m.e./L. It may be said that the chemical nature of the river water influences the adjacent soil properties which gradually affects the distinct chemical nature of the near by lake waters whereas such effects are conspicuously absent in lakes situated away from the river bank as in the case of Diwan lake. The values of pH and residual carbonate recorded in the table-1 show that lake waters are always alkaline and have free residual carbonate. Fig-2 further reflects the range of variations in average mineral compositions within lakes. For example, Ca^{++} ranges from 1.5 m.e./L in Diwan lake to 5.4 m.e./L in Sadir lake; Mg^{++} between 0.9 m.e./L in Diwan lake to 4.8 m.e./L in Sadir lake etc. The Sadir lake stands out clearly from the others in the figure to contain highest concentration of mineral constituents and consequent high values for SSP and SAR. The lowest values for above constituents, however, range between the Diwan and Scortechin lakes. The figure-2a also demonstrates the annual range of variation of the chemical concentration for each lake. For example, the Ca^{++} concentration in lake-2 (Prain) ranges from 2.2 m.e./L to 3.5 m.e./L, lowest limit being in August while the highest is in April; in lake-8 (Sadir) these range from 2.9 m.e./L to 8.2 m.e./L for the same cation and the lowest concentration being in December and the highest in June respectively. Barring a few exception incidence of usually lowest mineral concentration and the related properties and that of the highest attributes coincide with the months of August to December for the lower range and February to June for the higher range respectively. It may be interpreted that between the periods from August to December the total precipitation effect in the lake waters becomes greater than the corresponding rate of evaporation, and consequently, number of charged particles decrease per unit volume of water; whereas in the periods between February to June, owing to the higher rate of evaporation from the water surface the total volume of water decreases significantly, and therefore, the number of particles get increased per unit volume.

Table 2 shows the mean annual incidence of communities of vegetation such as the free-floating, rooted submerged/semi-emergent and amphibious types within and in the immediate vicinity of the standing waters around each lake referred above. It is evident from the table that the Sadir lake waters with high mineral contents harbour communities of *Lemna-Pistia, Hydrilla-Vallisneria* etc. The lakes are subjected to

Table 1 : Mean Annual EC, pH and Residual Carbonates of the lake waters

Lakes	EC in m. mhos/cm	pH	Residual CO_3^{--} in m.e./L.
Dhobi	2.77	8.5	0.6
Prain	2.52	8.4	0.19
King	2.87	8.4	0.6
Scortechin	0.92	8.4	0.23
Kunstler	1.53	8.3	0.02
Diwan	0.84	8.3	0.2
Janardan	1.65	8.6	0.42
Sadir	5.08	8.7	—
Leram	2.92	8.6	0.15

Table 2 : Mean Annual incidence of vegetation communities (Par Domin Scale, *loc. cit*)

Vegetation Incidence	Lakes*								
	1	2	3	9	8	7	5	4	6
Free floating									
Algal mass	2	3	4	2	3	—	—	—	—
Azolla pinnata R. Br.	1	—	—	2	2	—	1	—	1
Eichhornia crassipes (Mart.) Solms.	4	8	1	1	—	—	—	1	2
Lemna minor Linn.	—	—	1	4	8	—	5	—	1
Pistia stratoites Linn.	—	—	—	4	6	—	—	2	6
Salvinia auriculata Aubl.	1	3	3	3	—	—	5	—	1
Rooted Submerged									
Aponogeton natans (Linn.) Engl. *et* Krause	—	—	—	—	—	2	—	4	—
Hydrilla verticillata (Linn.) Royle	8	5	5	3	5	—	—	3	3
Otellia alismoides (Linn.) Pers.	1	—	—	—	—	2	—	1	—
Vallisneria spiralis Linn.	6	3	3	3	5	4	—	2	2
Semi-Emergent									
Ceratophyllum dumersum Linn.	—	—	3	4	5	3	6	—	2
Ludwigia adscendens (Linn.) Hara	2	1	1	—	—	2	2	2	2
L. perenis Linn.	—	1	1	—	2	1	1	—	—
Nelumbo nucifera Gaertn.	—	6	—	5	5	—	—	1	—
Nymphoides cristata (Roxb.) O. Kuntze	1	5	6	3	—	2	—	2	—
Nymphaea nouchali Burm. f.	—	2	3	6	2	—	—	2	—
N. stellata Willd.	2	—	—	—	—	—	6	—	5
Victoria amazonica (Poepp.) sow.	—	2	—	—	—	—	—	—	—

Amphibious									
Alternanthera philoxeroides (Mart.) Griseb.	2	2	2	3	3	—	5	2	3
A. sessilis (Linn.) DC.	1	4	2	2	1	1	2	3	2
Marsilea quadrifolia Linn.	—	—	—	2	2	—	—	—	—
Cyperus cephalotes Vahl	1	4	2	2	2	—	2	2	2
C. exaltatus Retz.	3	2	1	2	1	1	2	2	1
C. compressus Linn.	2	2	1	1	1	1	2	1	2
C. haspan Linn.	1	2	2	—	—	1	1	1	1
C. iria Linn.	2	2	1	1	2	2	2	1	2
C. papyrus Linn.	1	2	2	1	1	1	1	2	—
Polygonum barbatum Linn.	2	2	5	2	2	2	4	2	2
P. glabrum Willd.	2	1	2	2	2	3	2	1	1
P. hydropiper Linn.	1	1	2	2	1	—	1	1	2
P. orientale Linn.	2	1	1	1	2	1	1	1	1
Scirpus articulatus Linn.	1	5	2	3	1	1	2	3	2
S. squarrosus Linn.	2	2	3	2	1	—	1	2	1
Terrestional									
Echinocloa colonum (Linn.) Link.	2	4	4	4	—	—	—	1	—
Panicum repens Linn.	1	2	1	3	3	1	2	—	—
Paspalum conjugatum Berg.	—	—	1	2	2	—	2	1	—
Setaria glauca (Linn.) Beauv.	2	3	3	2	1	1	2	1	2

*Lakes : 1-*Dhobi* ; 2-*Prain* ; 3-*King* ; 9-*Leram* ; 8-*Sadir* ; 7-*Janardan* ; 5-*Kunstler* ; 6-*Scortechin* ; 4-*Diwan*.

Table 3 : Correlation co-efficient between mineral quantity and qualities of lake waters

Variates	Mean	Variance	S. D.	Covariance	Corr. Co-efficient (r)
EC	2.34	1.74	1.32	—	—
SSP	56.6	94.68	9.73	9.92	+0.79*
SAR	4.4	3.80	1.95	2.47	+0.96**

Significant at the level of : (*) .... 5% (**) .... 5% and 1%

acute human interferences and hence it is very difficult to categorise the communities strictly according to their salt tolerance capacities. However, a perusal of table-2 and fig-2b may reveal the species incidence and their salt tolerance ranges. For example, the common species like *Pistia, Hydrilla* and *Vallisneria* etc. can thrive well in extreme ranges of electrical conductivity between 0.49 m.mhos/cm to 6.8 m.mhos/cm and between varied ranges of SSP and SAR from 38 to 80 and 1.8 to 8.7 respectively. The species of *Eichhornia* though seemed abundant in the waters of the garden are located dominantly in the lake-2 (Prain) with *Salvinia* and floating mass of algae which is maintained for the culture of *Nelumbo* species where EC is in between 1.4 to 4.3 m.mhos/c.m.; SAR 2.4 to 7.7 and SSP 45 to 68 ; but the species is conspicuously absent when salinity values are greater, for example in Sadir lake.

The periodical fluctuations in quantitative and qualitative characteristics of lake waters are shown in fig. 3. It is clear from the figure that the quantities and their resultant qualities have a close affinity which is also evident from table-3 where a correlation bet-

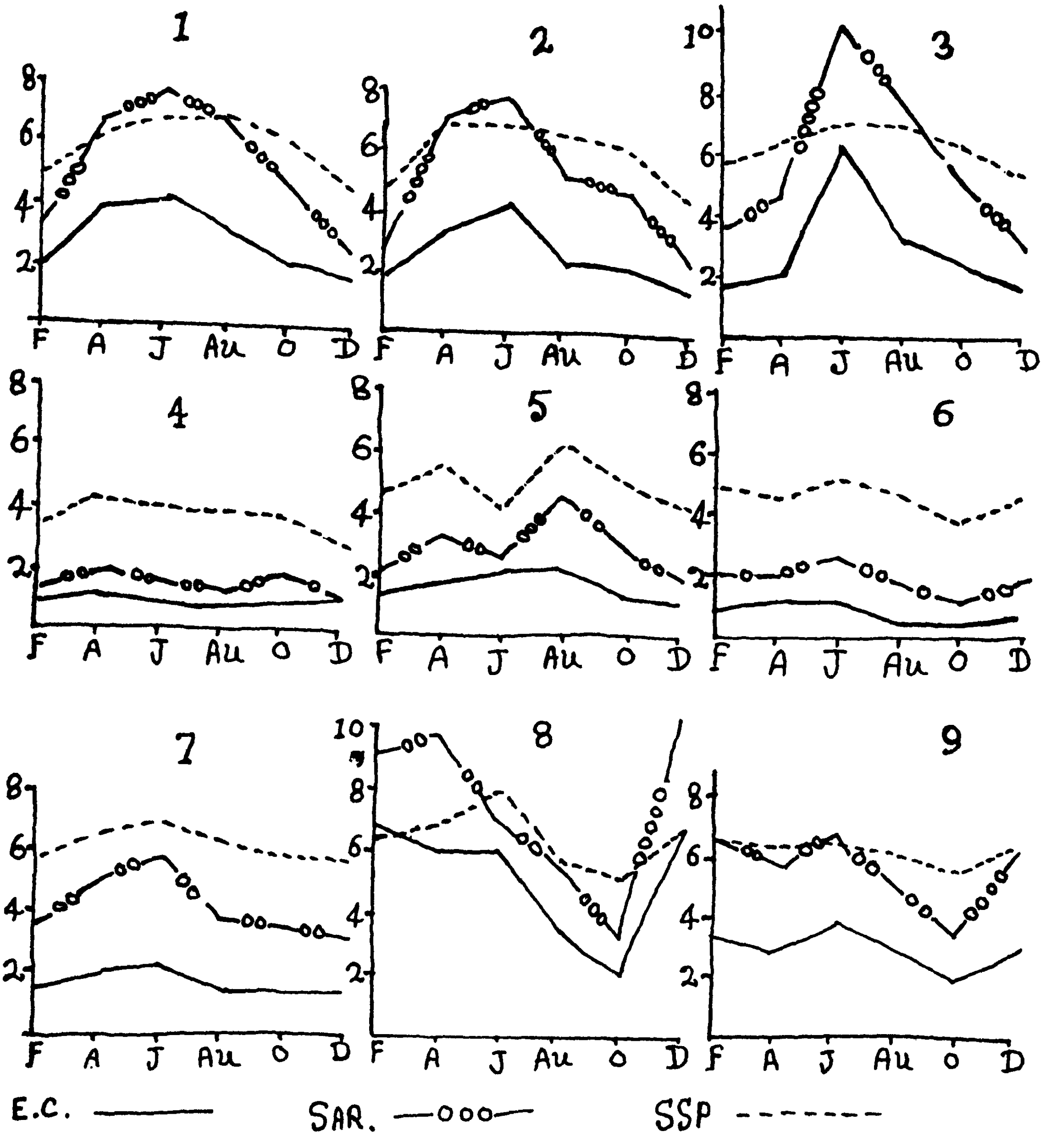

Fig. 3. Showing the periodical relationships among SSP (Soluble Sodium percentage), SAR (Sodium absorption ratio) & EC (Electrical conductivity) for each Lake.

Numbers given in Y axis showing the values of EC. in m.m.os/cm SAR. and 1/10th of the SSP. percentage.

F-February ; A-April ; J-June ; Au-August ; O-October & D-December.

ween EC and SSP, and EC and SAR have been worked out. Therefore, the amplitude of various communities within these lakes is associated with the varying ranges of chemical properties of waters as apparent from the afore-mentioned data.

CONCLUSION

It is evident from the study made so far that the aquatic environment of the Indian Botanic Garden is noted to be ecologically divergent. The diversity inherent *in situ* is significant for the incidence and abundance of various plant communities of the lakes. In fact the botanic areas of the garden are not free from biotic disturbances and the resultant communities are not strictly natural in disposition. The apparent heterogeneity as noted in the bio-aquatic environments of the area is due to the disposition of the water bodies in the garden and the impact of seasonal cycles coupled with the interruptions as a consequence of the regular interferences by man.

The location of lakes is incidental to the establishment of the garden on the river bank and the concomitant changes in their bio-aquatic environment are due to the temporal influences (Misra, 1946). These are a natural aspect where as the artificiality is induced through human interactions. These impacts have disturbed not only the natural preserves of the water but also some are manually and mechanically tampered with to give room to the new plants for introduction or simply for the cleanliness of waters. It is apparent, therefore, that the formation of plant communities of these waters are not in response to the natural consequences of the changes brought about by their local situation and concomitant changes induced by the varying periodicity of the climate but it is governed by the man made attributes. The inherent heterogeneity of the Indian Botanic Garden, therefore, can be rationally utilised and conserved for aqua-culture of species demanding favourable media which are available in plenty here in these lakes.

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